

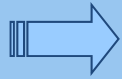
# FREEZING UNDER STATIC ELECTRIC FIELD

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15th Oct 2013



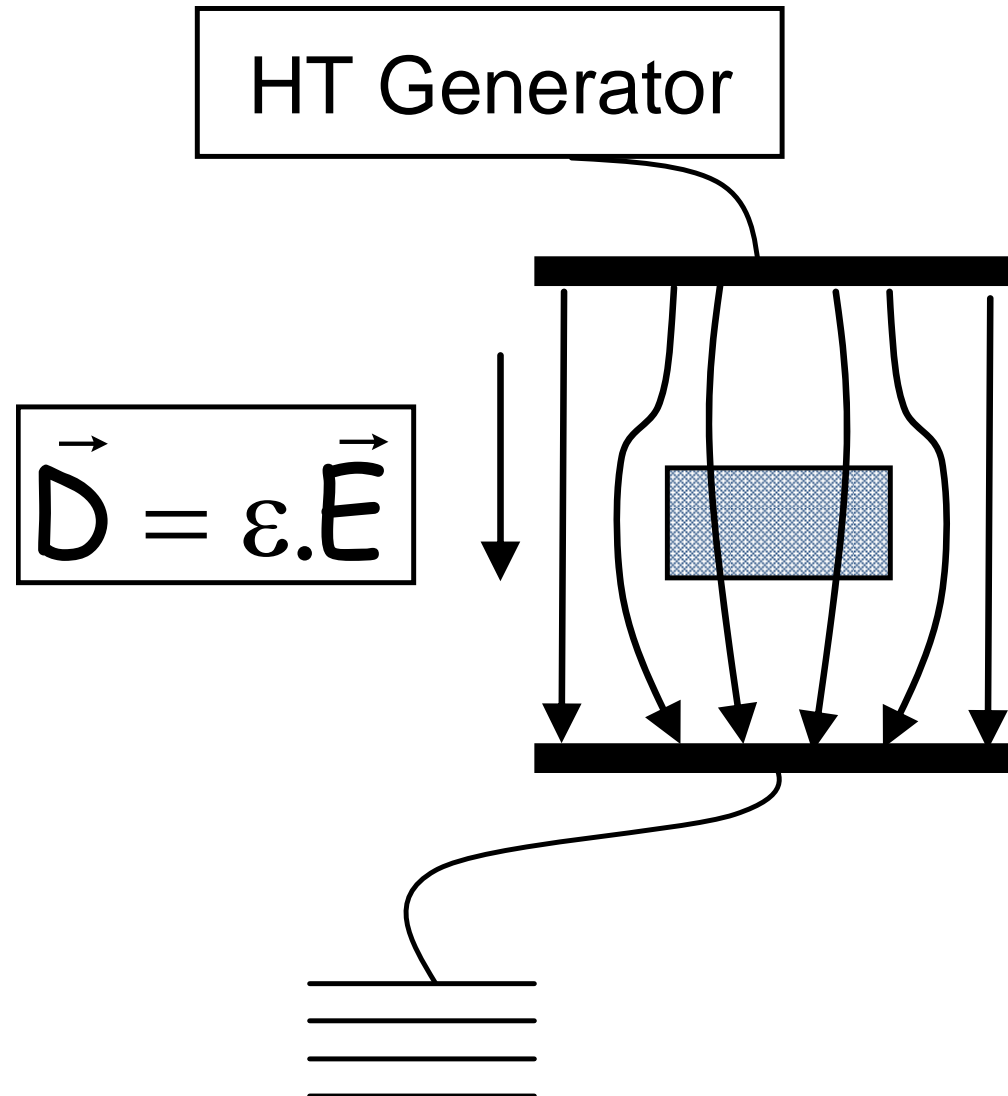
## FREEZING UNDER ELECTRIC FIELD





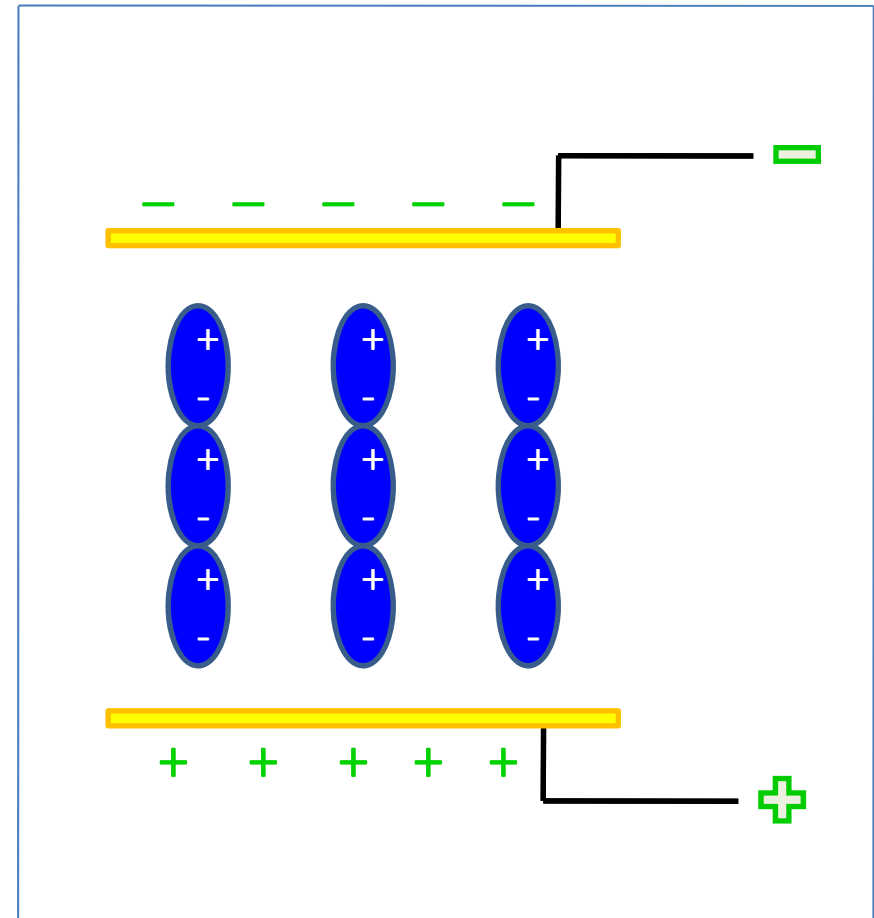
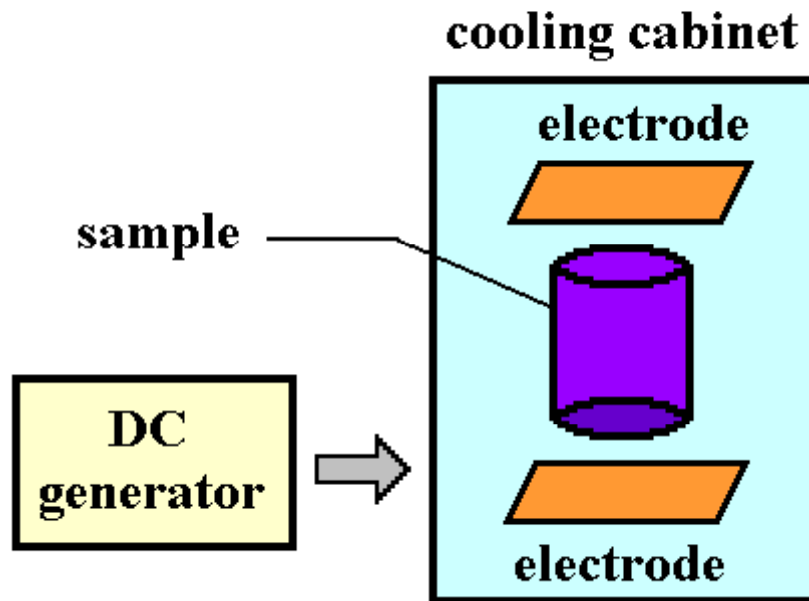
## ELECTRIC FIELD APPLICATION

External electric field applied to a real medium → a current flows



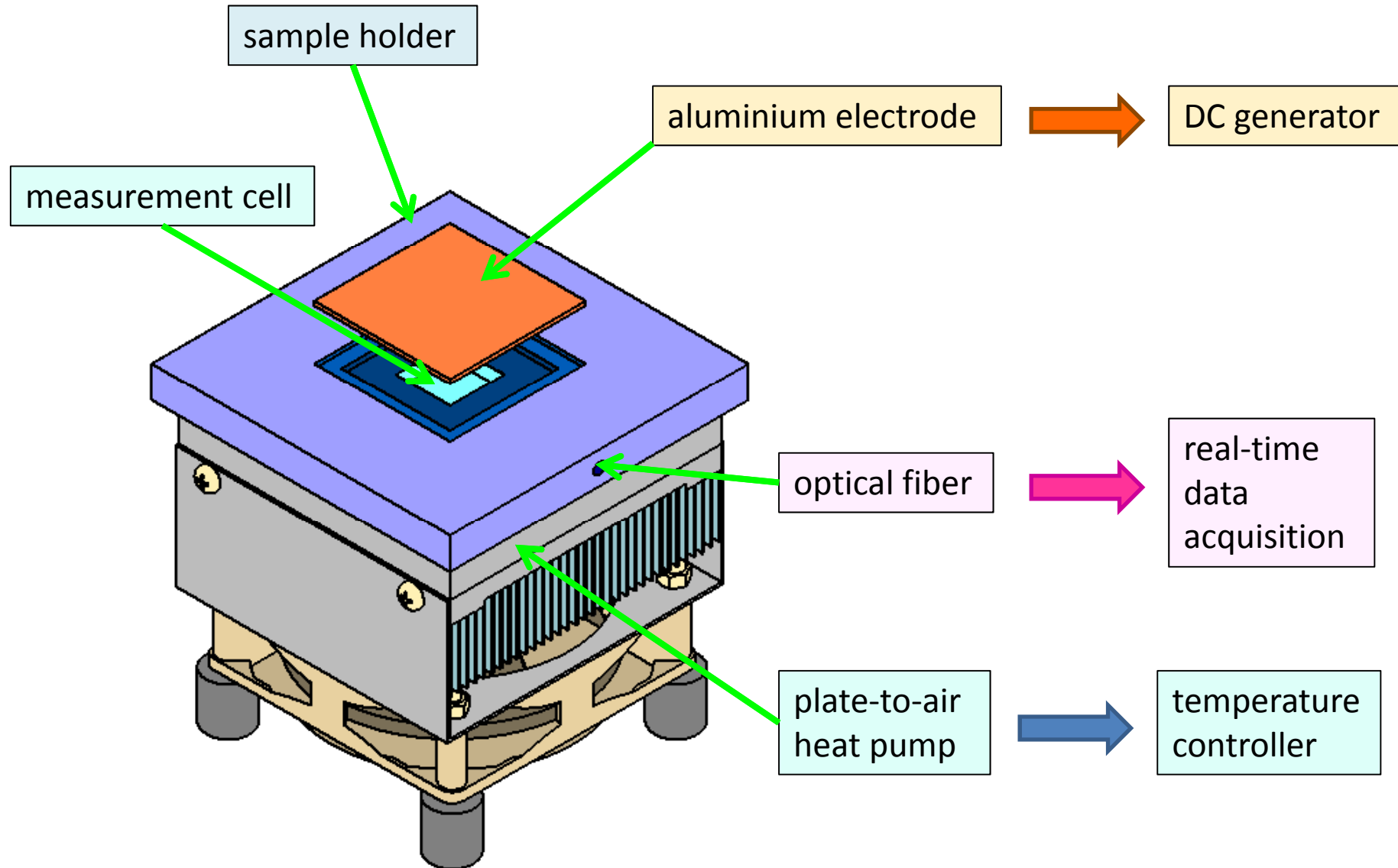
# ELECTROFREEZING via strong electric field

Wei et al. Cryobiology 56 (2008) 93–99



# EXPERIMENTAL SETUP

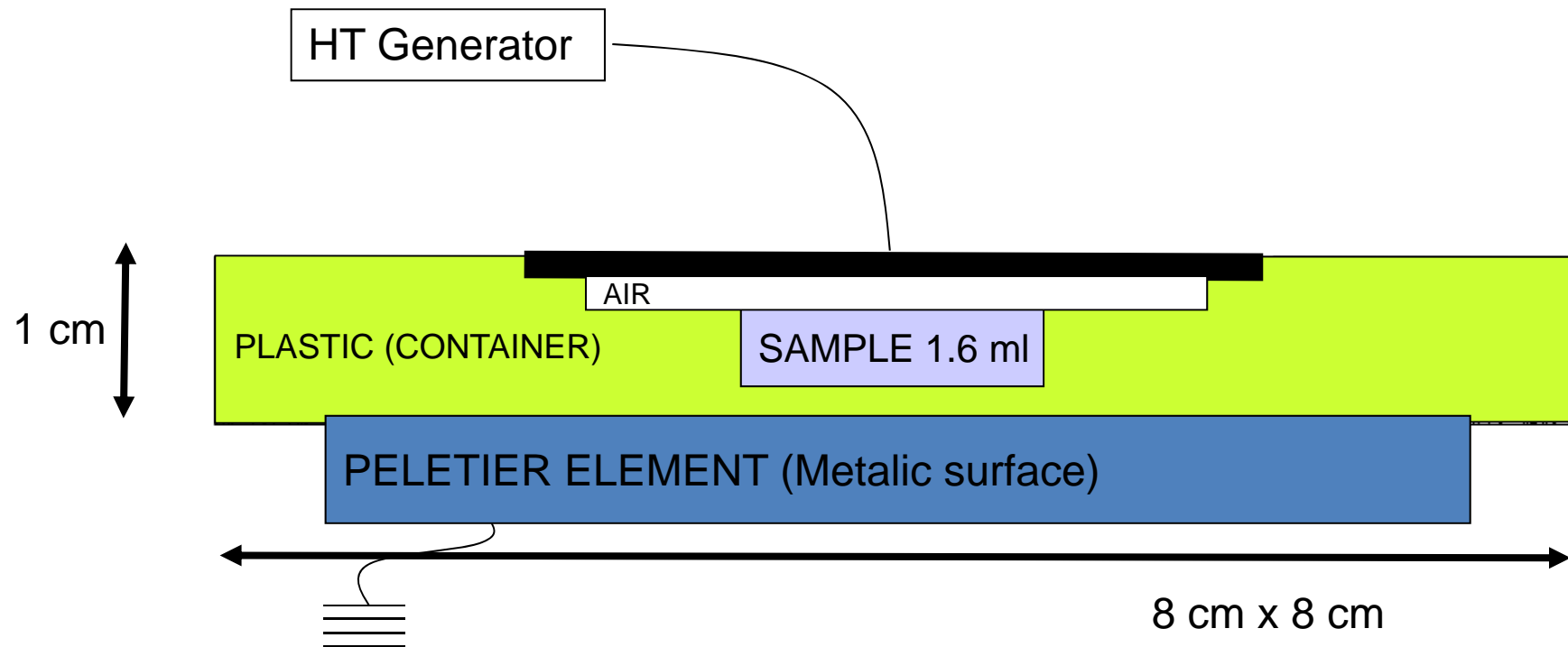
SYSTEM DESIGNED AT ENITIAA



# EXPERIMENTAL SETUP

CFD EVALUATION OF EFFECTIVE ELECTRIC FIELD IN THE SAMPLE (comsol)

Dielectric permittivities : air = 1, container (plastic) = 3.6 and water = 80



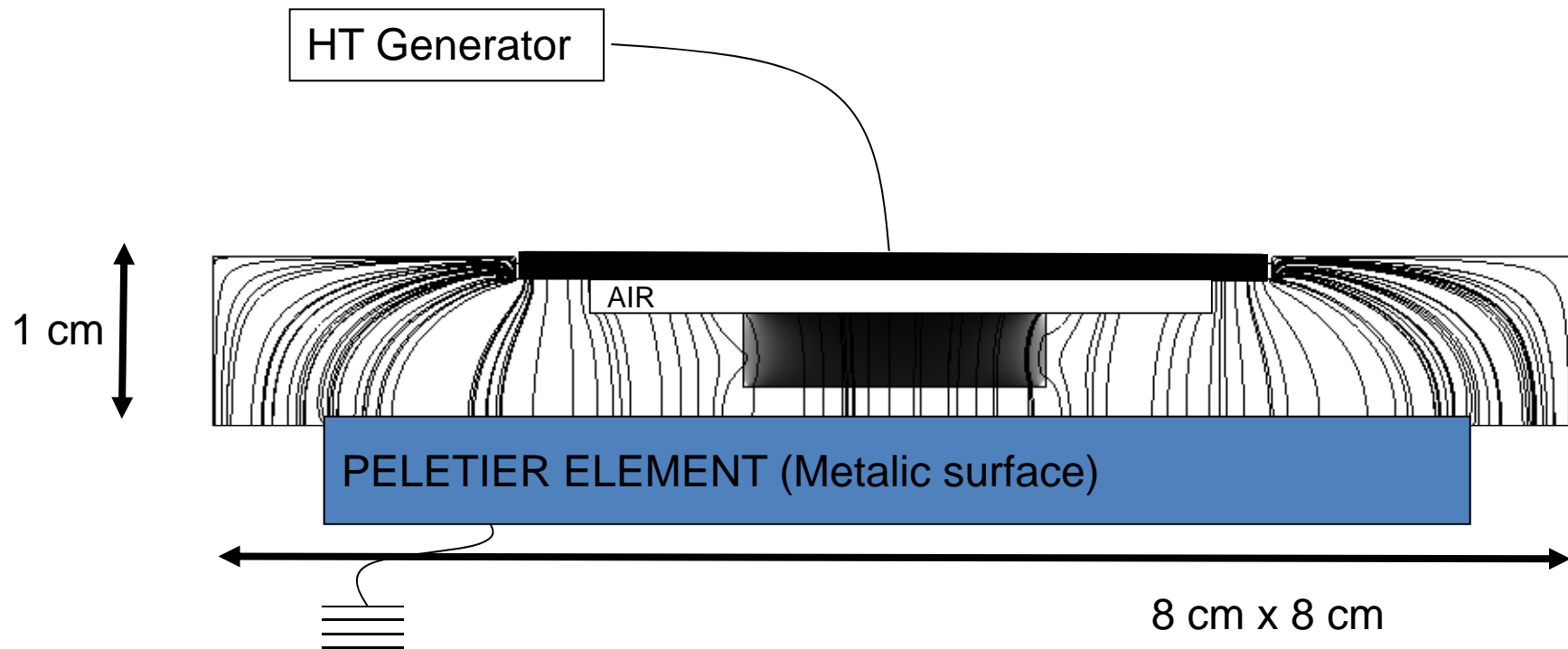
Effects of an electrostatic field on ice nucleation

Michel Havet, Marta Orlowska & Alain LeBail - *BFE 2009 - Compiègne, France, October 22-23 2009*

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# ELECTROFREEZING of distilled water

## Experimental procedure:

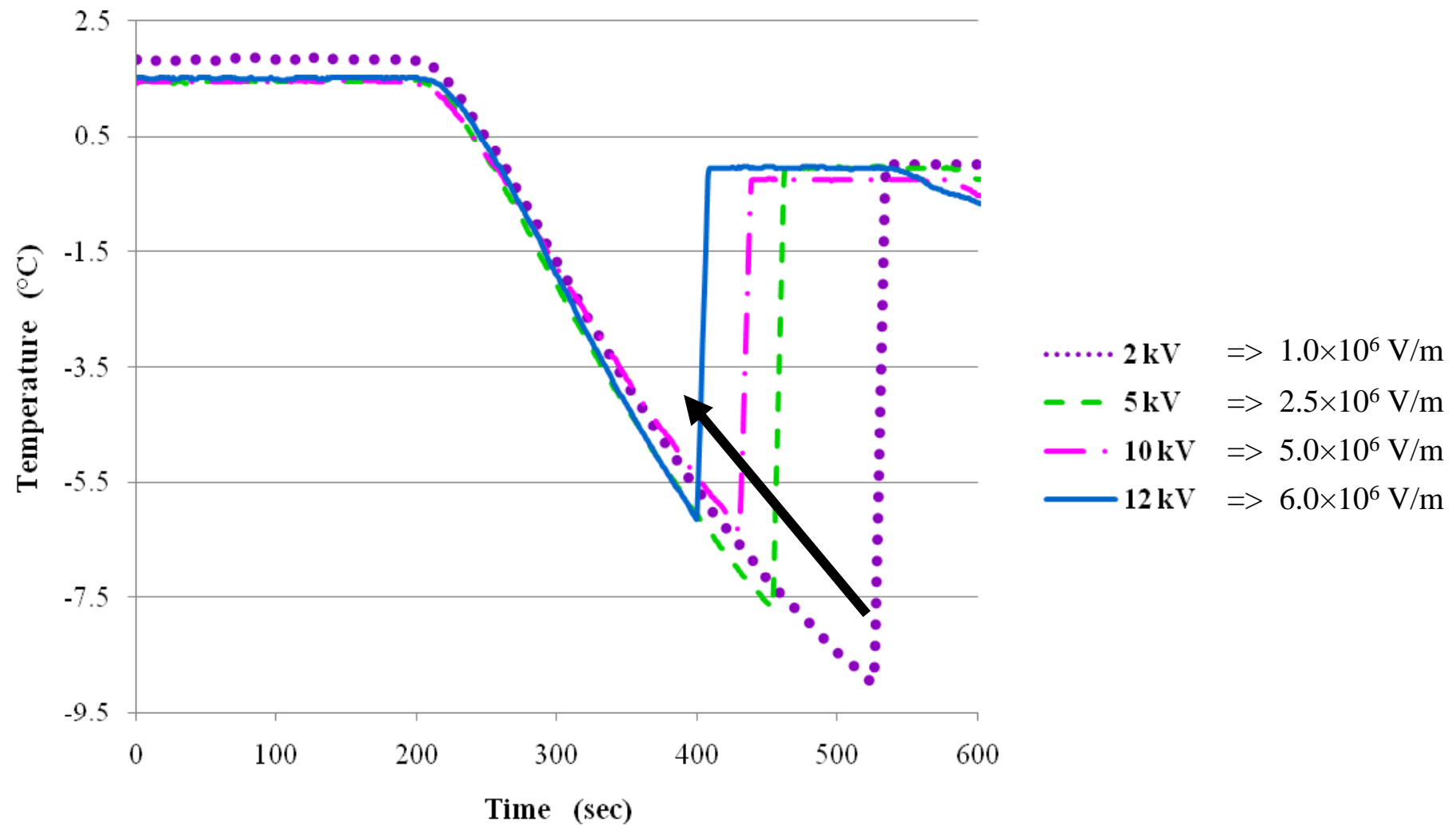
1. pre-cooling of the water sample (1.6 ml) at 1 °C
2. calibration of the optical fiber
3. cooling of the sample up to -16 °C under applied high voltage conditions

Voltage (kV)	Electric field (V/m)
0	0
2	$1.0 \times 10^6$
5	$2.5 \times 10^6$
10	$5.0 \times 10^6$
12	$6.0 \times 10^6$



*Temperature profiles obtained  
under different electrostatic field conditions*

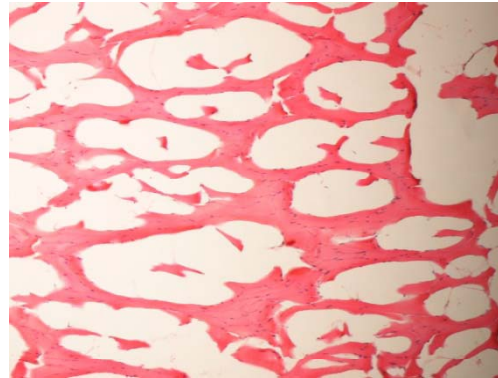
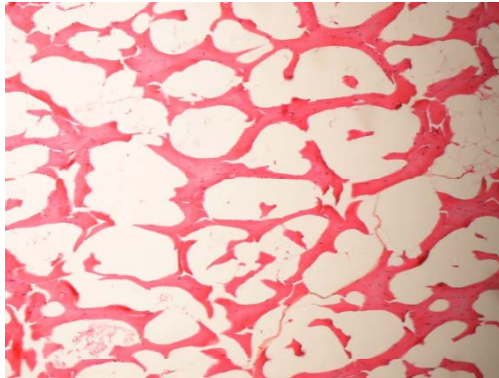
WATER



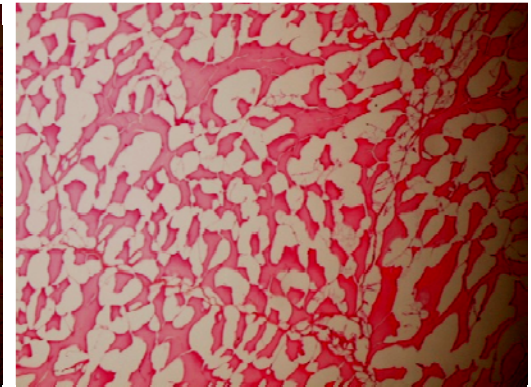
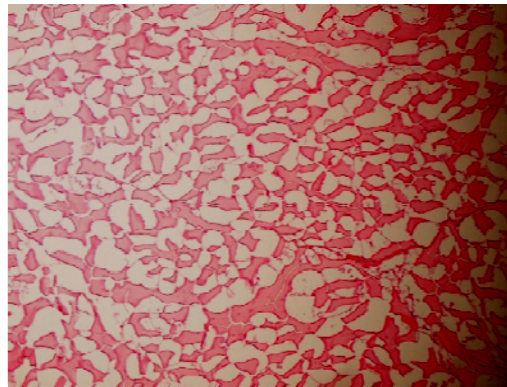
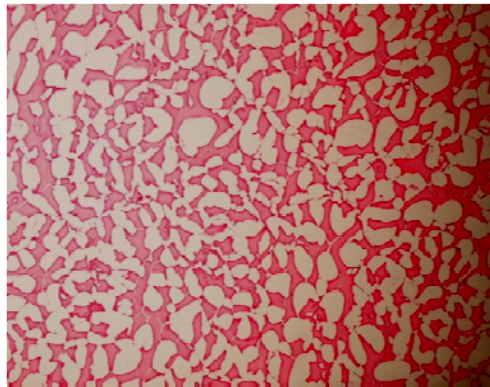


## ELECTROFREEZING: PORK MEAT

NO FIELD



12 kV  
 $6.10^6 \text{V/m}$

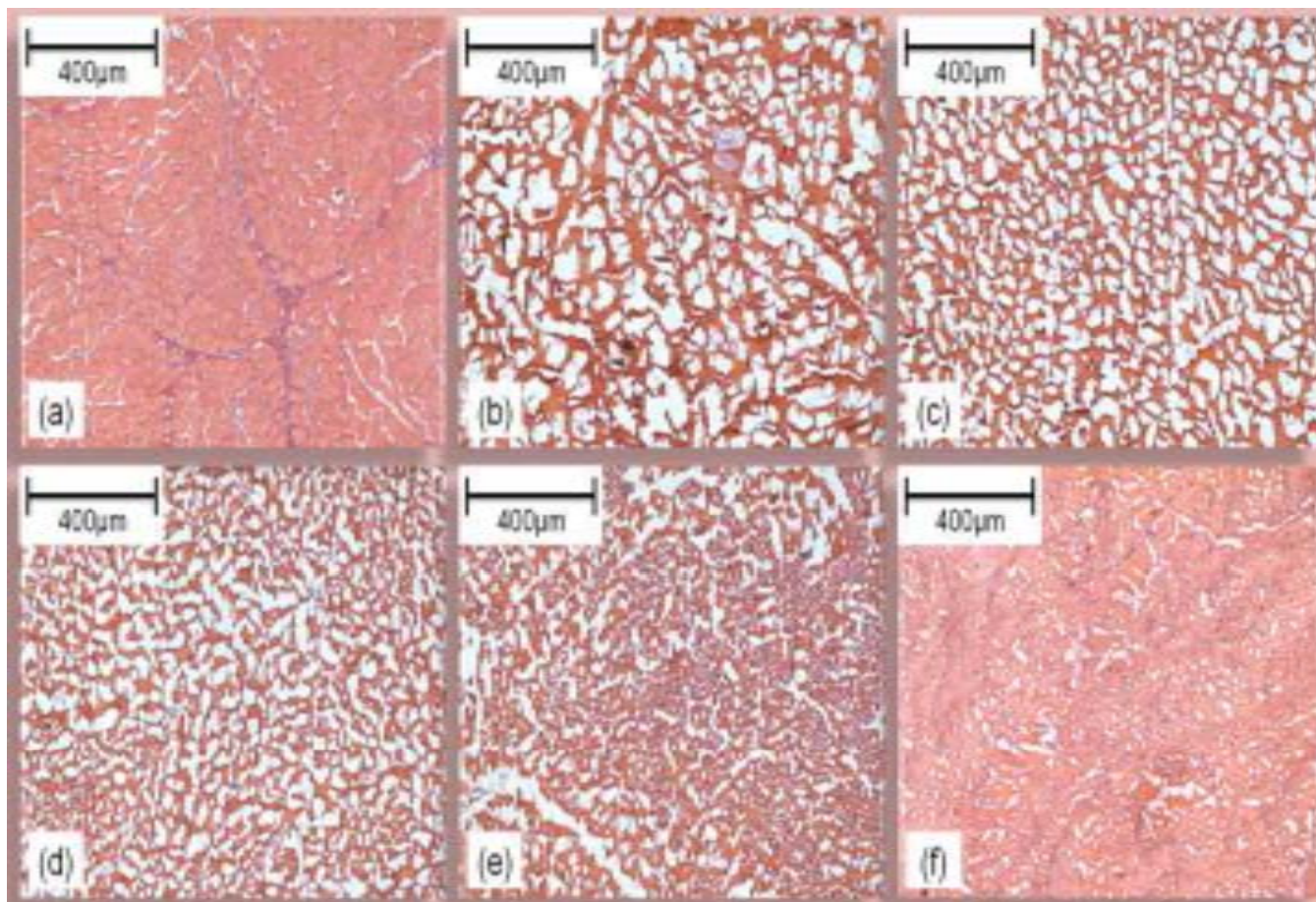


100μm

Ref: Le-Bail et al. Unpublished  
MSc THIAM – ONIRIS – 2011



## ELECTROFREEZING: PORK MEAT



Figure

Micrograph images of frozen pork tenderloin transversal cuts under different magnitude static electric fields. (a) Fresh meat, (b) 0 kV, (c) 3 kV, (d) 6 kV, (e) 9 kV, (f) 12 kV.





## ELECTROFREEZING: references

IFSET – 2013 – Accepted article - Reference: INNFOO1032

EFFECT OF STATIC ELECTRIC FIELD ON ICE CRYSTAL SIZE REDUCTION DURING FREEZING OF PORK MEAT

Innovative Food Science and Emerging Technologies Corresponding author: Prof. A. LE-BAIL First author: Dr. E. XANTHAKIS

Orlowska, M., M. Havet, and A. Le-Bail, Controlled ice nucleation under high voltage DC electrostatic field conditions. Food Research International, 2009. 42: p. 879-884.

Le-Bail, A., M. Orlowska, and M. Havet, Electrostatic Field Assisted Food Freezing - Chapter 30, in Handbook of Frozen Food Processing and Packaging, 2nd Edition, D.W. Sun, Editor. 2011, Springer: London

Le-Bail, A., M. Orlowska, and M. Havet. Possible interest of electric field during food freezing; a review on electrofreezing. in 1st IIR Conference on Sustainability and the cold chain. 2010. Cambridge, UK 29th, 30th and 31st March 2010 International Institute of Refrigeration Paper 240

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